Systematic prevention of overweight and obesity in adults: a qualitative and quantitative literature analysis.

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Obesity Prevention

Systematic prevention of overweight and obesity in adults: a qualitative and quantitative literature analysis

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Summary

To date, most interventions aimed at preventing obesity have underemphasized the application of systematic intervention development, implementation and evaluation. The present review provides a thorough insight in factors promoting implementation and/or effectiveness in interventions aimed at preventing overweight/obesity among adults. A total of 46 studies evaluating interventions aimed at preventing obesity were reviewed, followed by both qualitative and quantitative analyses. The Intervention Mapping protocol and the Environmental Research framework for weight Gain prevention (EnRG) were applied to analyse and classify the included studies. The interventions were categorized by setting (workplace, community, health care) and target group (ethnic minorities, pregnant women, [pre]menopausal women, smokers, people with intellectual disabilities). Generally, interventions were found to have potential in changing energy balance-related behaviours and anthropometric outcomes. Effect sizes for changes in body mass index ranged between –0.09 and 0.45. When the programme goal specifically aimed at weight management, the intervention was found to be more successful than interventions with programme goals that were aimed at preventing cardiovascular disease or improving general health status. Although a considerable part of studies included motivational interventions, only some actually assessed the effects on potential cognitive mediators. A general lack of reporting underlying theoretical models for behaviour change was observed as well as the inclusion of linkage groups and strategies to promote empowerment.

Keywords: Adults, overweight, prevention, review.

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Introduction

The prevalence rates of obesity and overweight are rapidly increasing, and the 'obesity epidemic' is globally recognized (1–3). Obesity has become one of the major risks to health as it is associated with a wide spectrum of chronic diseases. Lifestyle changes in dietary intake and physical activity contribute to the present situation (3). Although to date interventions have mostly focused on weight loss, prevention of overweight and obesity has increasingly received scientific attention (1,4–11). The goal of these programmes usually is to prevent weight gain across population segments (12). The need for a systematic and theory-based integral approach in interventions has been emphasized (13), but both systematic reviews and meta-analyses addressing this issue are lacking.

The purpose of the present paper was to gain insight in theory-based factors promoting implementation and/or

effectiveness in interventions aimed at preventing overweight and obesity in the adult population (≥18 years). The review presents an overview of the evidence that studies have provided on promising and/or effective strategies to change (determinants of) excessive weight gain, and recommendations are given for future effectiveness and implementation studies.

Methods

Analytic framework

Several studies revealed that interventions that were developed and implemented in a systematic and planned way were more likely to be effective (14). The Intervention Mapping (IM) protocol is a useful planning framework in the field of overweight and obesity prevention (15,16) and can also be used to evaluate interventions on their merit and to establish gaps in knowledge. Therefore, the IM protocol (14) was applied to analyse the included studies. Although the empirical literature rarely describes all steps and tasks of the IM protocol, the following aspects were studied in the present study:

- Description of the target group.
- Programme goals and behavioural goals.
- Description of the intervention (components, strategies).
- Pilot work.
- Inclusion and use of strategies to increase sustainability.
- Evaluation of the programme.

Classification of interventions

The interventions will be categorized by target group (age, gender, nationality, ethnicity) and setting (workplace, community, health care). Additionally, the Environmental Research framework for weight Gain prevention (EnRG) is applied to classify interventions (17). This framework is proposed as a dual-process view on the environment–behaviour relationship in which energy balance-related behaviours can be the result of both indirect influences (i.e. the mediating role of behaviour-specific cognitions) and direct mechanisms (automatic, unconscious influences). EnRG integrates the ecological perspective on energy balance-related behaviour with the socio-cognitive view. The ecological approach incorporates the Analysis Grid for Environments Linked to Obesity Framework (18). This framework enables the identification of potential intervention settings and strategies by distinguishing four types of environments: physical, economic, political and socio-cultural. The other main ingredient of the EnRG model is derived from one of the most popular socio-cognitive behavioural determinants models, the Theory of Planned Behaviour (19). Using the EnRG framework to analyse and classify interventions may provide a better insight into specific theoretical contents of interventions.

Search strategy

For the present study, all individual papers in three recent reviews on interventions aimed at preventing obesity (1,3,12) were reviewed. Additionally, we updated these reviews by performing a literature search to identify relevant studies in 2006 and 2007. In addition to a review of personal archives, studies were searched in the computerized database of PubMed including the following keyword combinations: prevention, overweight, obesity, weight gain, community and workplace. Publications were screened on the title (one reviewer; A. R.) and second on the abstract (two reviewers independently of each other; A. R. and S. K.). In order to be included in the present study, studies had to (i) be published between January 1990 and the onset of the review; (ii) be written in English or Dutch; (iii) be primary studies and (iv) include one or more anthropometrical outcome measures (e.g. body weight, body mass index or skin-fold thickness).

Qualitative evaluation

The present study focused on lifestyle interventions aimed at prevention of overweight and obesity. Typically, primary programme objective of such interventions is weight management, prevention of weight gain or moderate weight loss. Included studies were examined using a standard data abstraction form. The studies were systematically evaluated on the quality of the intervention according to the IM protocol, the type of intervention according to the EnRG framework, the quality of the research design using the Maryland Scientific Method Scale (SMS) (Box 1) and effectiveness.

Quantitative evaluation

Multiple potential moderators of intervention effectiveness were distracted from the qualitative analyses (Tables S1–S16), and they were quantified. These potential moderators represented each of the steps of systematic health promotion. Each of the steps and tasks of the IM protocol, as described above, was operationalized in the following manners:

1. Description of the target group.
   - Sample characteristics: mean age, proportion of females in the sample.
   - Setting: community vs. other settings.
2. Programme goals and behavioural goals.
   - Programme goal: weight management vs. other goals.
   - Behavioural goal: diet and physical activity vs. single behaviours.

Box 1 The Maryland Scientific Method Scale, adapted for anthropometric outcome measures.

Level	Description
1	Correlation between the prevention programme and an anthropometric measure at one point in time.
2	Anthropometric measures before and after the programme but with no comparable control group.
3	A comparison between two matched groups, one with and one without the intervention.
4	Anthropometric measures before and after the programme with multiple experimental and comparison condition, controlling for other variables that influence outcome.
5	Random assignment of individuals to programme and control conditions plus anthropometric measures before and after the programme.

3. Description of the intervention.

• Cognitive and environmental goals: both types of goals included vs. one of both.

• The duration of the intervention period (number of months).

4. Pilot work.

• Use of pre-test or pilot test (yes/no).

5. Inclusion and use of strategies to increase sustainability.

• Inclusion of strategies to increase empowerment (yes/no).

6. Evaluation of the programme.

• The quality of the research design (SMS; Box 1).

• The use of formative evaluation (yes/no).

The operationalization of the research model does not aim at incorporating the full set of potential determinants of intervention effectiveness. However, it can be interpreted as a structured set of indicators of systematic prevention of overweight and obesity. We hypothesized that each of the indicators would be positively associated with intervention effect size.

We calculated effect sizes – Cohen's *d*; (20) – for tests of differential change in weight across the intervention and control conditions, by dividing weight changes by standard deviation (SD) of baseline weight. As Cohen's effect size (*d*) has an upward bias, we calculated an adjusted effect size obtained by multiplication with $[1 - 3/(4n - 9)]$ (21) (*n* being the sample size). To calculate the average adjusted effect size and its confidence interval (CI) as well as to perform a fixed-effects meta-regression examining potential moderators of the effect size, SPSS macros developed by Lipsey and Wilson (22) were used. Although other indicators of change in body composition were used in several trials such as skin-fold thickness and waist circumference, these latter outcomes were operationalized inconsistently and were collected only in a subset of trials. Effect size was calculated when the research design included a control group (SMS score ≥ 3), when the sample included more than 20 participants and when the necessary data (baseline body mass index/weight and SD as well as change in body mass index/weight of both intervention and control group) were available in the selected papers. In case of more than one intervention group, we assessed the effect size for the most intensive intervention.

Next to descriptive analyses, both univariate and multivariate fixed-effects meta-regression analyses were executed. We performed the *Q*-test to examine (residual) heterogeneity in order to determine the necessity of executing random-effects analyses. The potential moderators were first separately entered into the analysis model (univariate), followed by an analysis of the full model by simultaneously entering all variables. As a result of the relatively small number of studies in the analyses, the critical *P*-value was set at ≤ 0.15.

Results

Qualitative analyses

Worksites provide many opportunities to reinforce the adoption and maintenance of healthy lifestyle behaviours and to reach large numbers of individuals of various socio-economic levels and ethnic backgrounds. Five studies in which workplace interventions were evaluated are described in more detail in Tables S1 and S9 (23–27). The number of worksites in the selected intervention studies ranged 3–32 worksites, including a range of 299–2041 respondents. None of the studies reported specified data on ethnicity.

In a community-based approach, the community is defined as the context in which health, health behaviour and health promotion attempt to reduce the population burden of, for example, obesity and overweight. Usually, such interventions involve programmes in a neighbourhood, village or suburb. Fifteen community-based intervention studies were selected (see Tables S2 and S10) (28–42). The number of respondents included in the selected studies varied from 19 to 2829, and participants were primarily White Americans. The interventions were mainly developed and evaluated in the USA. One intervention study was executed in the Netherlands (40).

Five intervention studies were identified that targeted a general patient population or high-risk patients for primary

prevention (Tables S3 and S11) (43–47). All studies were conducted in the UK or the USA; the number of participants ranged from 40 to 12 472. Three studies included high-risk patients (44,45,47), and two studies were led by healthcare providers (43,46).

The fact that health disparities exist between racial and ethnic groups emphasizes the need to develop culturally appropriate programmes for diverse ethnic groups (14). We identified four studies that met the inclusion criteria (see Tables S4 and S12) (48–51). The participating individuals in the identified intervention studies were African–American women (49), Hispanics (48), women derived from diverse ethnic and socioeconomic backgrounds (50) as well as African–Americans (51).

Prevention of excessive gestational weight gain can be realized by effective interventions for pregnant women. Four studies were identified (see Tables S5 and S13) (52–55). The number of participating pregnant women varied from 79 to 560, and the majority was White (52–54).

For women, the years surrounding the menopause are associated with weight gain and increases in low-density lipoprotein-cholesterol and total cholesterol (56,57). Therefore, prevention of weight gain during this time in a women's life is an important health goal (Tables S6 and S14) (56–58). The Women's Health Initiative Dietary Modification Trial (58) included almost 49 000 women, whereas the Women's Healthy Lifestyle Project (56,57) included 535 women. Both interventions were long-term projects and conducted in the USA. The participating women were primarily White (>80%).

Individuals that quit smoking, especially women, report concerns about post-cessation weight gain. Eight studies were identified that investigated the effect of smoking cessation projects including weight-control interventions (Tables S7 and S15) (59–66). A total of six intervention studies included only female smokers (60–62,64–66), and two were targeted at both male and female smokers (59,63). The number of participants ranged from 67 to 417 smokers, and most studies were conducted in the USA.

Prevalence of overweight and obesity in persons with intellectual disability is at least as high as in the general population (67). A number of risk factors have been suggested to explain the increased prevalence of obesity in this group such as independent mobility, barriers to leisure and exercise facilities as well as specific syndromes. Two intervention studies were identified that targeted at adults with learning disabilities (68) and adults with Down's syndrome (67) (see Tables S8 and S16).

Quantitative analyses

Of the 46 identified studies, 28 studies (61%) were executed in the USA, 14 in Europe (five in UK), two in Australia and two in Canada. The participants in the studies ranged between 19 and 48 835 (mean 1892; SD 7328). Mean body mass index at baseline was 27.3 (SD 3.4). The mean age of the population across all included studies was 42.1 years (SD 9.8; Table 1). Excluding 18 studies that consisted exclusively of women (e.g. pregnant or [pre]menopausal women), the samples consisted of, on average, 58% (SD 21.0) of women. Mean duration of the interventions was 18.9 months (SD 22.4). Slightly less than half of the studies (45.7%) revealed significant intervention effects on body mass index. In total, 34 studies (74%) enabled the calculation of effect sizes (see Tables S9–S16 for effect sizes of individual studies).

The adjusted effect sizes ranged from –0.09 to 0.45; although the average was small (0.06), it significantly differed from 0 for both a fixed effects (95% CI = 0.04–0.08, $z = 7.20$, $P < 0.001$) and a random-effects analysis (95% CI = 0.04–0.08, $z = 6.75$, $P < 0.001$). As can be seen from Table 2, the univariate regressions showed that when the programme goal was specifically aimed at weight management, the intervention was found to be more successful than programme goals that were aimed at preventing cardiovascular disease or improving general health status (standardized $\beta = 0.37$; $P = 0.01$). Other relatively large positive standardized β ($P < 0.15$) were found for the application of a formative evaluation and the mean age of the sample. When the intervention was accompanied by a formative evaluation, this increased the effectiveness as measured through the adjusted effect size (standardized $\beta = 0.27$, $P = 0.12$). In addition, age was found to be negatively associated with programme effectiveness (standardized $\beta = -0.29$, $P = 0.11$), indicating that the interventions are less likely to result in an impact on the participants' body mass index as the target group is older. Examining the results of the multivariate model, again, focusing the programme on weight management was found to increase the effectiveness (standardized $\beta = 1.18$, $P = 0.01$). Additionally, duration of the intervention was found to be positively associated with intervention effectiveness at a level of $P \leq 0.15$, while the statistical significance of the explanatory value regarding both age and the use of a formative evaluation was reduced in comparison with the univariate models. No residual heterogeneity was detected ($Q = 10.44$, degree of freedom = 19, $P = 0.94$), indicating that no random-effects analysis was needed. This was supported by an additional random-effects analysis, showing that the variance of the random effects was virtually 0.

Discussion

To date, review studies have focused primarily on evidence regarding the effectiveness of overweight prevention interventions (1,3,4,10–12). To our knowledge, the present study is the first to apply a theory-based approach, within the framework of systematic health promotion, in

Table 1 Descriptive information regarding potential moderators of intervention effectiveness

Moderator	Number of studies (%)	Mean (standard deviation)
Mean age (years) of sample (range 19.7–62.3)		42.1 (9.8)
<30	5 (10.9)	
30–40	12 (26.1)	
40–50	18 (38.1)	
>50	11 (23.8)	
Female proportion in the sample (range 0–100)	74.8 (26.3)	
Workplace interventions	5 (10.9)	
Community-based interventions	15 (32.6)	
Interventions in healthcare setting	5 (10.9)	
Interventions for ethnic minorities	4 (8.7)	
Interventions for pregnant women	4 (8.7)	
Interventions for (pre)menopausal women	3 (6.5)	
Interventions for smoking cessation	8 (17.4)	
Interventions for people with intellectual disabilities	2 (4.3)	
Programme goal		
Weight management	32 (69.6)	
Cardiovascular disease prevention	12 (26.1)	
General health	2 (4.3)	
Behavioural goal		
Diet and physical activity	26 (56.5)	
Diet	6 (13.0)	
Physical activity	7 (15.2)	
No specific behavioural goal reported	7 (15.2)	
Intrapersonal/cognitive goals		
Awareness	26 (56.5)	
Knowledge	34 (73.9)	
Attitude	30 (65.2)	
Perceived social influence	19 (41.3)	
Self-efficacy	21 (45.7)	
Goal-setting	8 (17.4)	
Habit	1 (2.2)	
Taste preference	1 (2.2)	
Environmental goals		
Physical	9 (19.6)	
Political	5 (10.9)	
Economical	3 (6.5)	
Socio-cultural	14 (30.4)	
Both cognitive and environmental goals	21 (45.7)	
One of both types of goals	25 (54.3)	
Use of pre-test/pilot test		
Yes	12 (26.1)	
No	34 (73.9)	
Duration (months) of the intervention period (range 1.5–84)		18.9 (22.4)
Not reported	1 (2.2)	
<3	11 (23.9)	
3–6	9 (19.6)	
6–12	12 (26.1)	
>12	13 (28.3)	
Strategies to increase empowerment		
Yes	18 (39.1)	
No	28 (60.9)	
Quality of the research design (Maryland Scientific Method Scale [SMS]; range 2–5)		4.1 (1.0)
Anthropometric measures before and after the programme but with no comparable control group (SMS 2)	3 (6.5)	
A comparison between two matched groups, one with and one without the intervention (SMS 3)	10 (21.7)	
Anthropometric measures before and after the programme with multiple experimental and comparison condition, controlling for other variables that influence outcome (SMS 4)	12 (26.1)	
Random assignment of individuals to programme and control conditions plus anthropometric measures before and after the programme (SMS 5)	21 (45.7)	
Use of formative evaluation		
Yes	7 (15.2)	
No	39 (84.8)	
Significant intervention effect on body mass index		
Yes	21 (45.7)	
No	25 (54.3)	

Table 2 Results of the univariate and multivariate (enter procedure) fixed-effects meta-regression analyses, with adjusted effect size (Cohen's *d*) as dependent variable

	Univariate			Multivariate		
	β	*P*	R^2	β	*P*	R^2
Mean age of sample	–0.29	0.11	0.09	–0.16	0.74	0.65
Female proportion in the sample	–0.06	0.72	0.00	–0.04	0.94	
Intervention in community setting (no/yes)	0.07	0.67	0.01	0.24	0.60	
Programme goal weight management (no/yes)	0.37	0.03	0.14	1.18	0.01	
Behavioural goal diet and physical activity (no/yes)	0.10	0.56	0.01	–0.43	0.33	
Both cognitive and environmental goals (no/yes)	0.14	0.43	0.02	–0.28	0.62	
Duration of the intervention period (number of months)	–0.21	0.23	0.04	0.77	0.15	
Use of pre-test/pilot test (no/yes)	–0.20	0.26	0.04	–0.30	0.53	
Strategies to increase empowerment (no/yes)	0.13	0.45	0.02	0.00	0.99	
Quality of the research design (SMS)	–0.04	0.80	0.00	–0.02	0.97	
Use of formative evaluation (no/yes)	0.27	0.12	0.07	0.47	0.26	

SMS, Maryland Scientific Method Scale.

reviewing factors promoting effectiveness of interventions aimed at changing determinants of weight gain in adults. A total of 46 studies evaluating interventions aimed at preventing obesity were reviewed, followed by both qualitative and quantitative analyses.

Interventions were found to have potential in changing energy balance-related behaviours and anthropometric outcomes. Effect sizes for changes in body mass index ranged between –0.09 and 0.45, with a mean effect size of 0.06 (95% CI = 0.04–0.08). Although significantly different from 0, the mean effect size is small, and it is important to recognize that publication bias is likely to favour interventions that show positive impacts. Less-successful studies may not have been reported in the peer-reviewed literature.

As intervention components were generally not evaluated in isolation, it is unclear which separate intervention components contribute most strongly to the impact. Our quantitative analyses did show the importance of formulating the programme goal specifically towards weight management. Those interventions were found to be more successful than interventions that had more broadly defined programme goals (e.g. prevention of cardiovascular disease or improving general health status). The results of the meta-analysis also indicate the importance of executing a formative or process evaluation in addition to assessing effects of the intervention on primary outcomes. Formative evaluation enables the intervention designers to guide programme development or to adapt the intervention as a consequence of identified barriers of successful implementation (14). The positive association between the uses of process-evaluative research methods may also be an indicator of the level of systematic development and implementation of the intervention. In addition, our results indicated that corrected for factors in our model longer interventions appeared to result in a larger effect size. The major problem with weight management programmes has been the difficulty of maintaining health behaviour changes and multiple authors and institutes have stressed the need for duration of programmes of longer than 5 years in order to assess the sustainability of behaviour change and the effects on weight (1,3,12). However, a majority of the identified intervention studies was not designed to show long-term effects on weight-related outcomes. This need for sustained interventions to prevent weight gain applies to all age groups. But it may especially be true for older target groups. Habits become more and more routinized as the behaviours are more frequently performed, and physical abilities and the corresponding variety of opportunities to be physically active decrease as people grow older. These characteristics require interventions to apply a continuous lifestyle approach that incorporates knowledge and promotion of personal opportunities to engage in behaviours that enable the maintenance of an energy balance.

A considerable part of interventions included motivational interventions, but only some studies actually assessed the intervention effects on potential cognitive mediators. In order to gain insight into the effectiveness of the intervention strategies in positively influencing specific cognitive mediators, it is recommended to investigate and report these effects. Although we feel that research aimed at investigating causal chains should primarily be subject of research in smaller scale, relatively controlled experimental research settings, the operationalization of cognitive changes as intermediary indicators is likely to provide important information about the necessary elements of programmes. However, accurate assessment of nutrition, physical activity and psychosocial factors without annoying respondents with very long questionnaires remains challenging.

Although the inclusion criteria for the present review were relatively broad and led to a large number of included

studies, the selected studies may still lack several interesting important approaches in the area. For example, faith or church-based interventions may represent a valuable development in the attempt to more efficiently reach ethnic minority groups (69). Although a general lack of this type of interventions has been observed recently (69,70), we did encounter some interesting manuscripts on this issue (71–73). For various reasons, e.g. not incorporating anthropometric outcomes (74), many of these approaches were not reviewed in our study.

A general lack of reporting underlying theoretical models and applied methods for behaviour change was observed. The use of theoretical frameworks may increase effective intervention development and potentially generates data that can be analysed more efficiently and effectively (75). Consequently, the processes underlying successful or unsuccessful interventions will be revealed. An interesting development in this respect is the formation of the Workgroup for Intervention Development and Evaluation Research Group (76), dedicated to improving standards in conduct and reporting of behaviour change interventions. We recommend intervention designers and researchers to increasingly apply systematic approaches in the design, implementation and long-term evaluation of interventions.

Conflict of Interest Statement

No conflict of interest was declared.

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References

1. Hardeman W, Griffin S, Johnston M, Kinmonth AL, Wareham NJ. Interventions to prevent weight gain: a systematic review of psychological models and behaviour change methods. *Int J Obes* 2000; **24**: 131–143.
2. Health Council. *Overgewicht en Obesitas [Overweight and Obesity*]. Netherlands Health Council: The Hague, 2003.
3. National Institute for Health and Clinical Excellence. *Obesity: Guidance on the Prevention, Identification, Assessment and Management of Overweight and Obesity in Adults and Children*. National Institute for Health and Clinical Excellence: London, 2006.
4. Fogelholm M, Kukkonen-Harjula K. Does physical activity prevent weight gain – a systematic review. *Obes Rev* 2000; **1**: 95–111.
5. Carraro R, Garcia Cebrián M. Role of prevention in the contention of the obesity epidemic. *Eur J Clin Nutr* 2003; **57**: S94–S96.
6. Davey RC. The obesity epidemic: too much food for thought? *Br J Sports Med* 2004; **38**: 360–363.
7. Mullis RM, Blair SN, Aronne LJ, Bier DM, Denke MA, Dietz W, Donato KA, Drewnowski A, French SA, Howard BV, Robinson TN, Swinburn B, Wechsler H. Prevention Conference VII: obesity, a worldwide epidemic related to heart disease and stroke: group IV: prevention/treatment. *Circulation* 2004; **110**: 484–488.
8. Matson-Koffman DM, Brownstein JN, Neiner JA, Greaney ML. A site-specific literature review of policy and environmental interventions that promote physical activity and nutrition for cardiovascular health: what works? *Am J Health Promot* 2005; **19**: 167–193.
9. Shaw K, O'Rourke P, Del Mar C, Kenardy J. Psychological interventions for overweight or obesity. *Cochrane Database Syst Rev* 2005; **2**: 1–62.
10. Brown T, Kelly S, Summerbell C. Prevention of obesity: a review of interventions. *Obes Rev* 2007; **8**: 127–130.
11. Lemmens VEPP, Oenema A, Klepp KI, Henriksen HB. A systematic review of the evidence regarding efficacy of obesity prevention interventions among adults. *Obes Rev* 2008; **9**: 446–455.
12. Winnet RA, Tate DF, Anderson ES, Wojcik JR, Winnet SG. Long-term weight gain prevention: a theoretically based Internet approach. *Prev Med* 2005; **41**: 629–641.
13. Brug J, van Lenthe FJ, Kremers SP. Revisiting Kurt Lewin: how to gain insight into environmental correlates of obesogenic behaviors. *Am J Prev Med* 2006; **31**: 525–529.
14. Bartholomew LK, Parcel GS, Kok G, Gottlieb NH. *Planning Health Promotion Programs: An Intervention Mapping Approach*. John Wiley & Sons, Inc.: San Francisco, CA, 2006.
15. Voedingscentrum. *Nederland in Balans: Masterplan Preventie Overgewicht 2005–2010 [The Netherlands in Balance: Masterplan Overweight Prevention 2005–2010]*. Voedingscentrum: The Hague, 2005.
16. Visscher TLS, Kremers SPJ, Kromhout D. *Preventie van Gewichtsstijging en en Richtlijnen voor Gewichtsbeheersing [Prevention of Weight Gain and Guidelines for Weight Management]*. Netherlands Heart Foundation: The Hague, 2007.
17. Kremers SP, de Bruijn GJ, Visscher TL, van Mechelen W, de Vries NK, Brug J. Environmental influences on energy balance-related behaviors: a dual-process view. *Int J Behav Nutr Phys Act* 2006; **3**: 9.
18. Swinburn B, Egger G, Raza F. Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity. *Prev Med* 1999; **29**: 563–570.
19. Ajzen I. The Theory of Planned Behavior. *Organ Behav Hum Decis Process* 1991; **50**: 179–211.
20. Cohen J. A power primer. *Psychol Bull* 1992; **112**: 155–159.
21. White IR, Thomas J. Standardized mean differences in individually-randomized and cluster-randomized trials, with application to meta-analysis. *Clin Trials* 2005; **2**: 141–151.
22. Lipsey MW, Wilson DB. *Practical Meta-analysis*. Sage: Newbury Park, CA, 2001.
23. Gomel M, Oldenburg B, Simpson JM, Owen N. Work-site cardiovascular risk reduction: a randomized trial of health risk assessment, education, counseling, and incentives. *Am J Public Health* 1993; **83**: 1231–1238.
24. Jeffery RW, Forster JL, French SA, Kelder SH, Lando HA, McGovern PG, Jacobs DR Jr, Baxter JE. The Healthy Worker Project: a work-site intervention for weight control and smoking cessation. *Am J Public Health* 1993; **83**: 395–401.
25. Braeckman L, De Bacquer D, Maes L, De Backer G. Effects of a low-intensity worksite-based nutrition intervention. *Occup Med* 1999; **49**: 549–555.

26. Proper KI, Hildebrandt VH, Van der Beek AJ, Twisk JW, Van Mechelen W. Effect of individual counseling on physical activity fitness and health: a randomized controlled trial in a workplace setting. *Am J Prev Med* 2003; **24**: 218–226.
27. Kwak LN. *The NHF-NRG in Balance Project Department of Human Biology*. Maastricht University: Maastricht, 2007.
28. Murray DM, Kurth C, Mullis R, Jeffery RW. Cholesterol reduction through low-intensity interventions: results from the Minnesota Heart Health Program. *Prev Med* 1990; **19**: 181–189.
29. Shelley E, Daly L, Collins C, Christie M, Conroy R, Gibney M, Hickey N, Kelleher C, Kilcoyne PL, Mulcahy R, Murray P, O'Dwyer T, Radic A, Graham I. Cardiovascular risk factor changes in the Kilkenny Health Project. A community health promotion programme. *Eur Heart J* 1995; **16**: 752–760.
30. Baxter T, Milner P, Wilson K, Leaf M, Nicholl J, Freeman J, Cooper N. A cost effective, community based heart health promotion project in England: prospective comparative study. *BMJ* 1997; **315**: 582–585.
31. Jeffery RW, French SA. Preventing weight gain in adults: design, methods and one year results from the Pound of Prevention Study. *Int J Obes* 1997; **21**: 457–464.
32. Jeffery RW, French SA. Preventing weight gain in adults: the Pound of Prevention Study. *Am J Public Health* 1999; **89**: 747–751.
33. O'Loughlin JL, Paradis G, Gray-Donald K, Renaud L. The impact of a community-based heart disease prevention program in a low-income, inner-city neighborhood. *Am J Public Health* 1999; **89**: 1819–1826.
34. Donnelly JE, Hill JO, Jacobsen DJ, Potteiger J, Sullivan DK, Johnson SL. Effects of a 16-month randomized controlled exercise trial on body weight and composition in young, overweight men and women: the Midwest Exercise Trial. *Arch Intern Med* 2003; **163**: 1343–1350.
35. Schmitz KH, Jensen MD, Kugler KC, Jeffery RW, Leon AS. Strength training for obesity prevention in midlife women. *Int J Obes Relat Metab Disord* 2003; **27**: 326–333.
36. Dzator JA, Hendrie D, Burke V, Gianguilio N, Gillam HF, Beilin LJ, Houghton S. A randomized trial of interactive group sessions achieved greater improvements in nutrition and physical activity at a tiny increase in cost. *J Clin Epidemiol* 2004; **57**: 610–619.
37. Slentz CA, Duscha BD, Johnson JL, Ketchum K, Aiken LB, Samsa GP, Houmard JA, Bales CW, Kraus WE. Effects of the amount of exercise on body weight, body composition, and measures of central obesity: STRRIDE-a randomized controlled study. *Arch Intern Med* 2004; **164**: 31–39.
38. Jenum AK, Anderssen SA, Birkeland KI, Holme I, Graff-Iversen S, Lorentzen C, Ommundsen Y, Raastad T, Odegaard AK, Bahr R. Promoting physical activity in a low-income multiethnic district: effects of a community intervention study to reduce risk factors for type 2 diabetes and cardiovascular disease: a community intervention reducing inactivity. *Diabetes Care* 2006; **29**: 1605–1612.
39. Levitsky DA, Garay J, Nausbaum M, Neighbors L, Dellavalle DM. Monitoring weight daily blocks the freshman weight gain: a model for combating the epidemic of obesity. *Int J Obes* 2006; **30**: 1003–1010.
40. Schuit AJ, Wendel-Vos GC, Verschuren WM, Ronckers ET, Ament A, Van Assema P, Van Ree J, Ruland EC. Effect of 5-year community intervention Hartslag Limburg on cardiovascular risk factors. *Am J Prev Med* 2006; **30**: 237–242.
41. Hivert MF, Langlois MF, Berard P, Cuerrier JP, Carpentier AC. Prevention of weight gain in young adults through a seminar-based intervention program. *Int J Obes* 2007; **31**: 1262–1269.
42. Salyer J, Flattery M, Joyner P, Friend J, Elswick RK Jr. Community-based weight management in long-term heart transplant recipients: a pilot study. *Prog Transplant* 2007; **17**: 315–323.
43. Family Heart Study Group. Randomised controlled trial evaluating cardiovascular screening and intervention in general practice: principal results of British family heart study. *BMJ* 1994; **308**: 313–320.
44. Andersen RE, Wadden TA, Bartlett SJ, Zemel B, Verde TJ, Franckowiak SC. Effects of lifestyle acivity vs. structured aerobic exercise in obese women: a randomized trial. *JAMA* 1999; **281**: 335–340.
45. Riebe D, Greene GW, Ruggiero L, Stillwell KM, Blissmer B, Nigg CR, Caldwell M. Evaluation of a healthy-lifestyle approach to weight management. *Prev Med* 2003; **36**: 45–54.
46. Jackson C, Coe A, Cheater FM, Wroe S. Specialist health visitor-led weight management intervention in primary care: exploratory evaluation. *J Adv Nurs* 2007; **58**: 23–34.
47. McConnon A, Kirk SF, Cockroft JE, Harvey EL, Greenwood DC, Thomas JD, Ransley JK, Bojke L. The Internet for weight control in an obese sample: results of a randomised controlled trial. *BMC Health Serv Res* 2007; **7**: 206.
48. Howard-Pitney B, Winkleby MA, Albright CL, Bruce B, Fortmann SP. The Stanford Nutrition Action Program: a dietary fat intervention for low-literacy adults. *Am J Public Health* 1997; **87**: 1971–1976.
49. Yanek LR, Becker DM, Moy TF, Gittelsohn J, Koffman DM. Project Joy: faith based cardiovascular health promotion for African–American women. *Public Health Rep* 2001; **116**(Suppl. 1): 68–81.
50. Hall WD, Feng Z, George VA, Lewis CE, Oberman A, Huber M, Fouad M, Cutler JA. Low-fat diet: effect on anthropometrics, blood pressure, glucose, and insulin in older women. *Ethn Dis* 2003; **13**: 337–343.
51. Winett RA, Anderson ES, Wojcik JR, Winett SG, Bowden T. Guide to Health: nutrition and physical activity outcomes of a group-randomized trial of an Internet-based intervention in churches. *Ann Behav Med* 2007; **33**: 251–261.
52. Clapp JF III, Little KD. Effect of recreational exercise on pregnancy weight gain and subcutaneous fat deposition. *Med Sci Sports Exerc* 1995; **27**: 170–177.
53. Polley BA, Wing RR, Sims CJ. Randomized controlled trial to prevent excessive weight gain in pregnant women. *Int J Obes Relat Metab Disord* 2002; **26**: 1494–1502.
54. Olson CM, Strawderman MS, Reed RG. Efficacy of an intervention to prevent excessive gestational weight gain. *Am J Obstet Gynecol* 2004; **191**: 530–536.
55. Kinnunen TI, Pasanen M, Aittasalo M, Fogelholm M, Hilakivi-Clarke L, Weiderpass E, Louto R. Preventing excessive weight gain during pregnancy – a controlled trial in primary health care. *Eur J Clin Nutr* 2007; **61**: 884–891.
56. Kuller LH, Simkin-Silverman LR, Wing RR, Meilahn EN, Ives DG. Women's Healthy Lifestyle Project: a randomized clinical trial: results at 54 months. *Circulation* 2001; **103**: 32–37.
57. Simkin-Silverman LR, Wing RR, Boraz MA, Kuller LH. Lifestyle intervention can prevent weight gain during menopause: results from a 5-year randomized clinical trial. *Ann Behav Med* 2003; **26**: 212–220.
58. Howard BV, Manson JE, Stefanick ML, Beresford SA, Frank G, Jones B, Rodabough RJ, Snetselaar L, Thomson C, Tinker L, Vitolins M, Prentice R. Low-fat dietary pattern and weight change over 7 years: the Women's Health Initiative Dietary Modification Trial. *JAMA* 2006; **295**: 39–49.

59. Hall SM, Tunstall CD, Vila KL, Duffy J. Weight gain prevention and smoking cessation: cautionary findings. *Am J Public Health* 1992; **82**: 799–803.
60. Pirie PL, McBride CM, Hellerstedt W, Jeffery RW, Hatsukami D, Allen S, Lando H. Smoking cessation in women concerned about weight. *Am J Public Health* 1992; **82**: 1238–1243.
61. Danielsson T, Rossner S, Westin A. Open randomised trial of intermittent very low energy diet together with nicotine gum for stopping smoking in women who gained weight in previous attempts to quit. *BMJ* 1999; **319**: 490–493.
62. Marcus BH, Albrecht AE, King TK, Parisi AF, Pinto BM, Roberts M, Niaura RS, Abrams DB. The efficacy of exercise as an aid for smoking cessation in women: a randomized controlled trial. *Arch Intern Med* 1999; **159**: 1229–1234.
63. Jonsdottir D, Jonsdottir H. Does physical exercise in addition to a multicomponent smoking cessation program increase abstinence rate and suppress weight gain? An intervention study. *Scand J Caring Sci* 2001; **15**: 275–282.
64. Perkins KA, Marcus MD, Levine MD, D'Amico D, Miller A, Broge M, Ashcom J, Schiffman S. Cognitive-behavioral therapy to reduce weight concerns improves smoking cessation outcome in weight-concerned women. *J Consult Clin Psychol* 2001; **69**: 604–613.
65. Spring B, Doran N, Pagoto S, Schneider K, Pingitore R, Hedeker D. Randomized controlled trial for behavioral smoking and weight control treatment: effect of concurrent versus sequential intervention. *J Consult Clin Psychol* 2004; **72**: 785–796.
66. Copeland AL, Martin PD, Geiselman PJ, Rash CJ, Kendzor DE. Smoking cessation for weight-concerned women: group vs. individually tailored, dietary, and weight-control follow-up sessions. *Addict Behav* 2006; **31**: 115–127.
67. Rimmer JH, Heller T, Wang E, Valerio I. Improvements in physical fitness in adults with Down syndrome. *Am J Ment Retard* 2004; **109**: 165–174.
68. Chapman MJ, Craven MJ, Chadwick DD. Fighting Fit? An evaluation of health practitioner input to improve healthy living and reduce obesity for adults with learning disabilities. *J Intellect Disabil* 2005; **9**: 131–144.
69. Seo DC, Sa J. A meta-analysis of psycho-behavioral obesity interventions among US multiethnic and minority adults. *Prev Med* 2008; **47**: 573–582.
70. Kumanyika S. Ethnic minorities and weight control research priorities: where are we now and where do we need to be? *Prev Med* 2008; **47**: 583–586.
71. DeHaven MJ, Hunter IB, Wilder L, Walton JW, Berry J. Health programs in faith-based organizations: are they effective? *Am J Public Health* 2004; **94**: 1030–1036.
72. Baker EA, Kelly C, Barnidge E, Strayhorn J, Schootman M, Struthers J, Griffith D. The Garden of Eden: acknowledging the impact of race and class in efforts to decrease obesity rates. *Am J Public Health* 2006; **96**: 1170–1174.
73. Kim KH, Linnan L, Campbell MK, Brooks C, Koenig HG, Wiesen C. The WORD (wholeness, oneness, righteousness, deliverance): a faith-based weight-loss program utilizing a community-based participatory research approach. *Health Educ Behav* 2008; **35**: 634–650.
74. Resnicow K, Jackson A, Braithwaite R, DiIorio C, Blisset D, Rahotep S, Periasamy S. Healthy body/healthy spirit: a church-based nutrition and physical activity intervention. *Health Educ Res* 2002; **17**: 562–573.
75. The Improved Clinical Effectiveness through Behavioural Research Group (ICEBeRG). Designing theoretically-informed implementation interventions. *Implement Sci* 2006; **1**: 4–11.
76. Abraham C, Michie S. Standardising intervention descriptions: development of a reliable taxonomy of change techniques. *Health Psychol Rev* 2007; **1**(Suppl. 1): 257 (paper presented at the 21st conference of the European Health Psychology Society, Maastricht, the Netherlands, 15–18 August 2007).

Supporting information

Additional Supporting Information may be found in the online version of this article:

Table S1. Description of sample, intervention and implementation goals; workplace interventions.
Table S2. Description of sample, intervention and implementation goals; community-based interventions.
Table S3. Description of sample, intervention and implementation goals; interventions in healthcare setting.
Table S4. Description of sample, intervention and implementation goals; interventions for ethnic minorities.
Table S5. Description of sample, intervention and implementation goals; interventions for pregnant women.
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Table S9. Goals of the intervention, theoretical framework and evaluation; workplace interventions.
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